



# R.C.A. INSTITUTES

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## Technical Lesson 47

### CROSLEY R.F.L. 90---ZENITH 17

The Crosley R.F.L. 90 receiver incorporates three stages of tuned radio frequency, a non-regenerative detector, and two stages of transformer coupled audio frequency amplification.

Manufacturers of tuned radio frequency circuits employ various methods of cancelling out the effect of inter-electrode capacities of the vacuum tube, thus eliminating the possibility of oscillations. In certain types of receivers fixed resistance units are connected directly in the grid leads of the radio frequency tubes to prevent oscillations, and is known as the "grid suppressor" method. Circuits employing this method were taken up in a previous lesson.

In the circuit which is the subject of this lesson the inter-electrode capacities of the radio frequency tubes are cancelled; that is, balanced out by means of oscillation control. When employing a balanced circuit of this type the manufacturer builds it up about a certain type of vacuum tube and for this reason only vacuum tubes having the proper characteristics should be used in the radio frequency stages.

The circuit of the R.F.L. 90 is designed and so balanced at the factory that only the UX-201A or CX-301A type of vacuum tube, or vacuum tubes having identically the same or very similar characteristics, should be used in the radio frequency stages. Proper use of vacuum tubes in the radio frequency stages is therefore important if the best results are to be obtained.

In the detector stage a vacuum tube of the 200-A or 201-A type should be employed because the fixed filament resistance connected in the filament circuit of this tube is designed to be used in connection with vacuum tubes of the quarter ampere type. The use of vacuum tubes drawing one ampere should not be used, as for instance, the UV-200 type because it will overload this fixed resistor and if allowed to remain in the socket will cause the resistor to be damaged. The detector tube socket is the extreme right socket as seen when facing the front of the set.

Satisfactory reception may be obtained by using the UX-201A type vacuum tube in both audio frequency stages. To eliminate the possibility of distortion, however, if maximum volume is desired, a UX-112 or UX-171 type power tube should be inserted in the last audio frequency tube socket. Additional "B" and "C" battery terminals are provided in the last audio frequency stage to make possible the use of proper plate potential and grid bias necessary for good reproduction when either the UX-112 or UX-171 power tube is employed.

Plate potentials from 90 to 135 volts and a grid bias of 4.5 to 9 volts is applied when employing the UX-112 power tube. 90 to 180 volts plate potential with grid bias of 16.5 to 40.5 is applied when the UX-171 type power tube is placed in the circuit.

The installation of a power tube in the last stage of this set is largely a matter of personal opinion. One type is installed as easily as the other and no changes in the circuit itself are necessary. If more than 135 volts plate voltage (B battery) is utilized when the UX-171 power tube operates in the last stage it then becomes necessary to install a one to one ratio transformer between the power tube output terminals and the loudspeaker to prevent damage to the windings of the speaker unit. (See Figure 4). A white arrow on the sub-panel of the tube socket shelf designates the socket in which the power tube should be inserted.

All tubes in this set should be of the storage battery type. By storage battery tubes is meant those requiring filament voltage of five volts for normal operation. It is therefore recommended that either a 6 volt storage battery of at least 80 ampere hour capacity, or an efficient "A" battery eliminator be used.

For all amplifier tubes, both radio and audio frequency, not over 90 volts of "B" battery should be applied, with the exception of the power tube. For the detector tube use 45 volts "B" battery. The proper "C" battery voltage to use with various power tubes will always be found on the data sheet accompanying each tube.

Antenna and Ground: Generally an antenna 50 to 100 feet in length will be found efficient. To advise an antenna of specific length is not good practice because of the varying reception conditions that are found in different sections of the country. A 25 foot aerial in New York City would probably pick up sufficient signal energy to operate the set at maximum efficiency, while in the country, miles from a broadcasting station, 100 feet of aerial wire would be necessary to produce the same results. If the set is located very close to a broadcasting station even 15 or 20 feet, including lead-in, will be sufficient, and because this circuit is very sensitive short antennas are recommended when the location is in the immediate vicinity of powerful transmitters. When installing this set the service man should try out various antenna lengths until the one operating the most effective is found.

The ground lead should be connected either to a water pipe or to a rod driven in moist earth. Never use a gas pipe as the ground. Fire underwriters rules should be followed whenever possible relative to the installation of antenna and ground connections of receiving sets.

Connecting Batteries to Terminal Board: The terminal board at the rear of the set is provided with twelve terminal posts. Reading from left to right as you face the front of the set they are: Antenna posts, (Vol.A) and (Sel.A), ground (G), Positive "A" battery, Negative "B" battery (A+B-), loudspeaker output terminals marked "Musicone", Positive "B" battery 90 to 180 volts (B+90 to 180), Positive "B" battery 90 volts (B+90), Positive "B" battery 45 volts (B+45), Negative "C" battery 0

to 40 volts (C-0 to 40), Negative "C" battery 0 to 6 volts (C-0 to 6), Positive "C" battery, Negative "A" battery (C+A-). Figure 1 is a diagram of the terminal board of the Crosley Model R.F.L. 90, showing antenna, ground, storage battery, "B" battery, and loudspeaker connections. A six volt storage battery is included for supplying current to the tube filaments, and two 45 volt "B" batteries to furnish voltage to the plate circuits of the tubes.

The diagram, Figure 1, should be followed when six UX-201A vacuum tubes are employed and no "C" biasing battery. The metal jumpers which will be found connecting the "B" positive 90 to 180 binding post to the "B" positive 90 volt binding post should be left connected as shown, likewise the jumpers connecting the "C" negative zero to 40 volts. "C" negative zero to 6 volts, and "C" positive "A" negative binding posts should be connected as shown in Figure 1.

The antenna should be temporarily connected to first the aerial binding post "Vol.A" then to aerial binding post "Sel.A", and permanently connected to the one giving the best results, regardless of the overall length of the antenna wire.

The white arrow on the extreme left points to the second audio frequency tube socket and is the only socket in which a power tube is to be inserted. On the extreme right will be found a second white arrow which serves to point out the detector tube socket.

Figure 2 is the wiring diagram to be followed when six UX-201A type receiving tubes are employed together with a "C" battery. Since a "C" battery is now included in the complement of batteries, the metal jumper connecting the binding posts marked C-0 to 6 and C+A- must be opened. The figure clearly shows this operation as well as the added "C" battery.

When a UX-112 power tube is inserted in the last audio frequency stage an additional "B" battery and an extra "C" battery is necessary. The diagram, Figure 3, shows how the batteries are connected when five UX-201A tubes are used with a UX-112 power tube.

Since 135 volts plate voltage is applied to the power tube the jumper between the B+90 to 180 and B+90 binding posts is opened and separated so that no metallic connection exists between these posts. The jumper between C-0 to -40 and C-0 to -6, C+A- binding posts also must be opened. The proper size "C" battery, equipped with taps, to deliver the correct "C" bias must be used. When 135 volts plate potential is impressed on a UX-112 power tube 9 volts "C" bias must be used on the grid. If  $157\frac{1}{2}$  volts is applied to this tube,  $10\frac{1}{2}$  volts "C" bias is necessary.

Figure 4 shows the battery connections when a UX-171 tube is employed in the last stage. 180 volts "B" battery and 40 volts "C" battery is utilized in this instance. The instructions relative to opening the jumpers between the binding posts before installing "C" battery and "B" batteries, when over 90 volts is used, must be carefully followed. To neglect this will result in rapidly running down and ruining both "B" and "C" batteries.

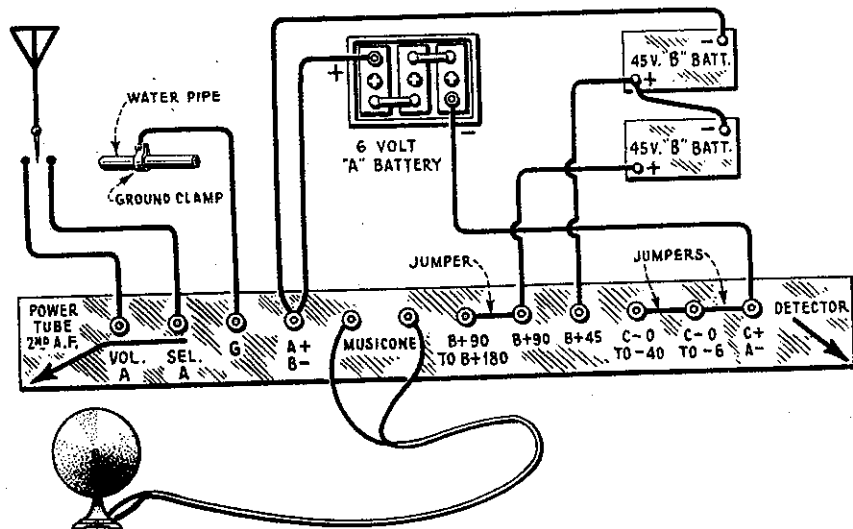


Figure 1

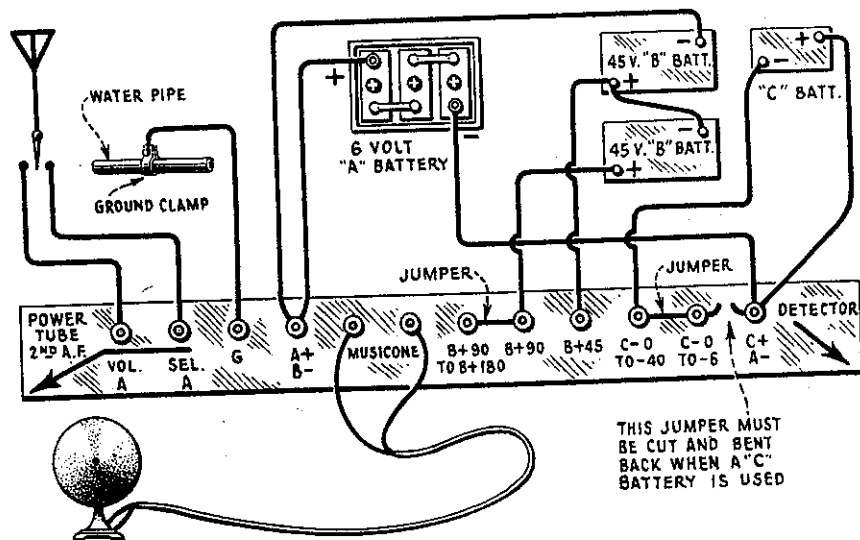


Figure 2

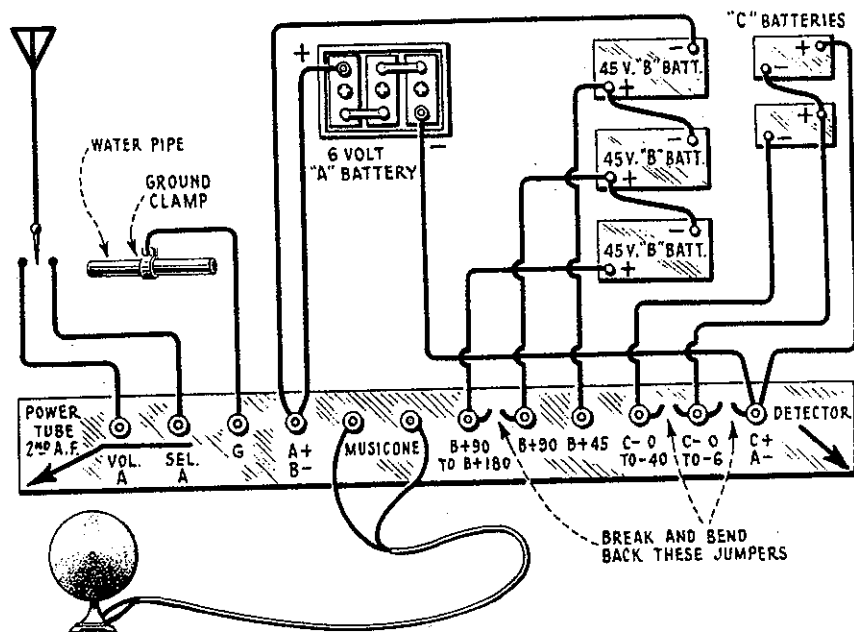


Figure 3

Filament Control: No filament rheostat is incorporated in this set to control the filament current; ballast; i.e., fixed resistors are connected in the filament circuit which automatically regulates the filament current. Turning the filament current "on" or "off" is accomplished by simply pulling out or pushing in the filament switch shown in Figure 5.

Volume Control: The volume is controlled by means of a rheostat connected in the filament circuit of the three radio frequency tubes. To increase volume turn this rheostat "ON". A decrease in volume is attained by turning this rheostat to the "OFF" position. When searching for a station this control should always be turned on full until the station is located, after which it can be gradually turned off until the desired volume results. Failure to observe this point may result in not locating many weak signals which would otherwise be heard.

Tuning: Tuning is accomplished by means of two drum type controls called "station selectors" and two other controls known as "acuminators". Figure 5 clearly shows their position on the panel of the set. To tune in a station signal, first adjust the volume control to its maximum "on" position; this causes the filaments of the three radio frequency tubes to heat to the maximum normal temperature. The acuminators should then be set to the approximate position for the station desired to be heard. The setting of these controls is learned through practice as the exact position may vary slightly with different installations. Station selectors 1 and 2 should then be rotated until a signal is heard. Now make close adjustments of both the station selectors and acuminators until the signal is received with maximum volume.

If, at this stage of the tuning procedure, the volume is excessive, turn the volume control toward the "off" position until the reproduction is pleasing both as to volume and clarity. The volume control is the only control that should be manipulated when a reduction of volume is desired. Detuning to obtain this result will in many cases cause the reproduced signal to be distorted. Detuning is, as the word implies, the opposite of tuning.

Tuning is the act of making such adjustments that the resistance of the receiving circuit, to a particular frequency, is reduced to the lowest point. When this is accomplished the circuit is then, in the true sense of the word, tuned to the frequency of the signal being received.

Detuning is the act of changing either the capacity of the tuning condenser, or the inductance of the tuning coil, so that the combination of capacity and inductance is no longer resonant; that is, the combination no longer offers the lowest possible resistance or opposition to the frequency of the signal. What really happens is the resistance of the circuit to the particular frequency has been increased. This method of controlling volume is, therefore, not satisfactory as it destroys the selectivity of the receiver and in many cases produces distortion because other stations transmitting on frequencies close to the frequency of the signal being received will pass through the circuit and this, of course, is not desirable. Station selectors and acuminator controls then should be adjusted until the circuit is resonant to the signal frequency being received and the volume brought to the desired intensity by adjustment

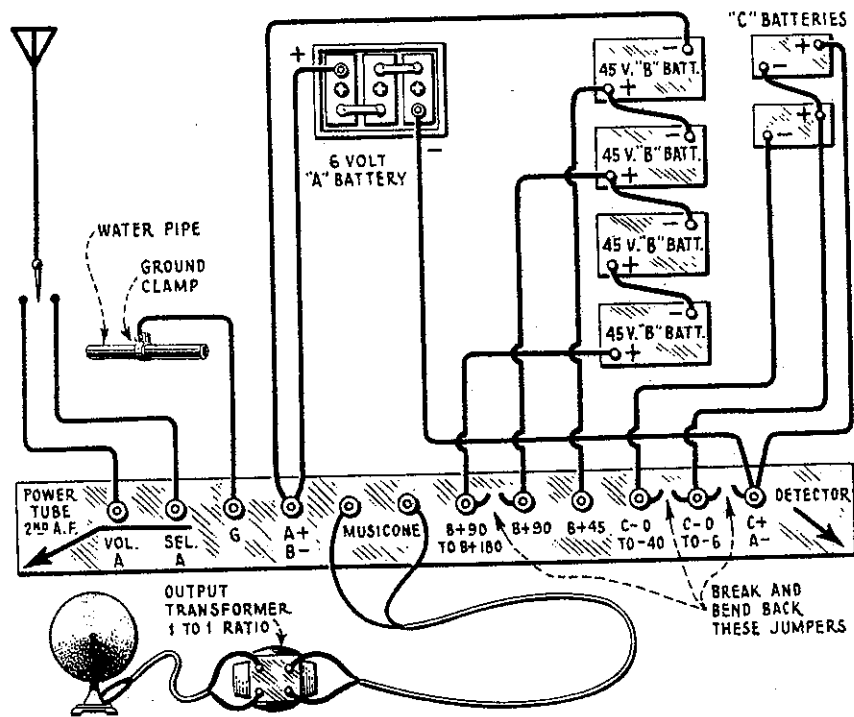


Figure 4

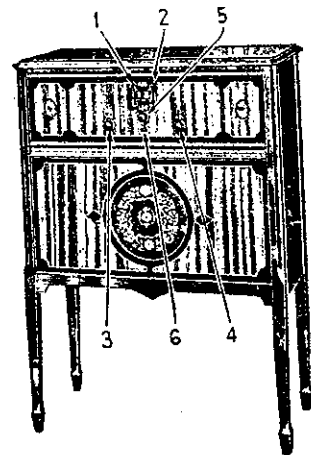


Figure 5

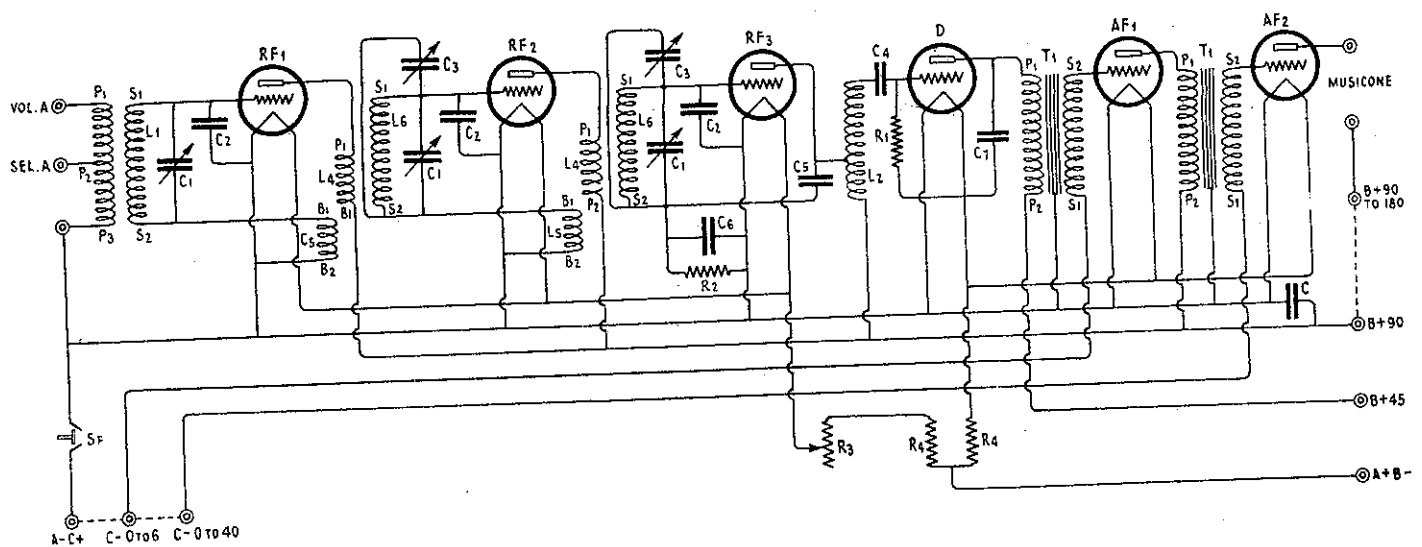


Figure 6

of the volume control knob only.

The various controls of the set shown in Figure 5 are:

- 1 and 2 Station selectors
- 3 and 4 Acuminator knobs
- 5 Volume control
- 6 Filament switch

The R.F.L. 90 Circuit: Figure 6 is a schematic diagram of the Crosley Model R.F.L. 90. The antenna circuit is coupled to the input of the first radio frequency stage RF1 by means of the radio frequency transformer L2, the primary of which is untuned. Two taps are provided on this primary coil to vary the coupling. The taps marked "Vol A" which is an abbreviation for "Volume Antenna", connects all of the turns of this coil in the circuit thus providing the greatest coupling which is conducive to maximum volume, "Sel A" is the symbol given to the second tap, an abbreviation for "Selective Antenna". In effect, the antenna inductance is decreased when this tap is utilized or, stated another way, the antenna has been shortened electrically. Decreased coupling is obtained and the system as a whole is more selective.

The main tuning condensers C1, C2, and C3 are connected in parallel (shunt) to the secondary windings of the radio frequency transformers L1 in the first stage, and L6 in the second and third stages respectively. One of the station selector drums control condenser C1 across the secondary coil L1, while the remaining station selector drum controls the two condensers C1 connected across the secondary coils L6 of the second and third R.F. transformers respectively.

Connected in shunt to the main condensers of the second and third R.F. stages are two small condensers marked C3 on the schematic diagram. Their function is to provide a means of fine or sharp tuning. In other words the circuit may be adjusted to resonance for a frequency which would be impossible to receive by rotating the main tuning condenser alone. These condensers are operated by means of the knobs on the front of the panel marked "Acuminator".

Balancing: The first two stages of this circuit are balanced to prevent uncontrolled oscillations by means of the balancing coils L5 and the small adjustable condensers C2. The advantage of this method of balancing is that it is independent of the wavelength of the received signal, making possible good balance throughout the entire broadcast wavelength range without sacrificing signal volume at the longer wavelength.

The third radio frequency stage (RF 3) is balanced by means of the small condensers C6, C5, and C2, with a small fixed resistance R2 shunted across C6. The condenser C2 is adjustable and set at the factory. No balancing coils are used in this stage. The condensers C2, which are found in each of the radio frequency stages, are small adjustable condensers installed to balance the circuit for the 201A type tubes before the set leaves the factory. The adjustment of these condensers should not be changed unless tubes having different characteristics than the type named are used.

Detector and Audio Frequency Stages: The third radio frequency stage delivers its energy to the detector through an impedance transformer "L2". Condenser "C4" is the grid condenser, "R1" the grid lead, and condenser "C7" a by-pass condenser connected between the plate and positive side of the detector filament for the purpose of by-passing the radio frequency component of the plate current around the primary winding of the first audio frequency transformer "T1".

The two audio frequency stages are transformer coupled. Each transformer is of 4 to 1 ratio and completely enclosed in a grounded metal case. The primary and secondary terminal windings are brought through the case by means of insulated studs. Near each terminal stud the metal case is stamped with proper markings which designate the terminals of the two windings. For example, the plate terminal of the primary winding is marked P1; the opposite end of this winding which connects to the "B" battery is marked P2. The terminal of the secondary winding which connects to the grid element of the succeeding tube is marked "S2", while the opposite end of this winding, which connects to the C- and thence to filament A-, is marked "S1".

The condenser "C" in the audio frequency circuit, and shown in the schematic diagram Figure 6, connected across the B+ 90 to 180 binding post and the negative filament "A-" post, is a by-pass condenser placed there to by-pass the radio frequency component of the plate current around the "B" battery.

"C" Battery Connections: From the schematic diagram Figure 6 it will be seen that only the audio frequency stages are provided with "C" battery terminals. Two "C" terminals are provided so that a greater bias may be applied to the plate of the last audio frequency stage if a power tube requiring high plate voltage is employed. If no "C" bias is used and the jumpers (see battery wiring diagram Figure 1) are left intact the grids of the audio frequency tubes are connected direct; i.e., through the audio frequency transformer secondaries to the filament of the audio frequency tubes. Since there is no voltage drop between the filament and grid through the medium of a filament rheostat or ballast resistance, as in some radio sets, the only biasing voltage applied to the grid is, therefore, that of the "C" batteries used.

Testing: Before a test is started the accessories, aerial and ground, should be thoroughly examined because in many instances the fault can be traced to the accessories. To make a circuit test of the set remove the chassis, supporting the circuit wiring and parts, from the cabinet and lay it bottom side up on the test table. This procedure will expose to view the more important parts and wiring. By means of a small camel hair brush remove all dust or other accumulation of dirt particles from the interior of the chassis, especially near uninsulated portions of the wiring and terminals.

The usual testing equipment may be used; that is, a pair of phones in series with a four volt battery, or the volt-meter method.

In testing the different parts of this circuit for faulty contacts, open or short circuits, the chart in Figure 7 has been prepared to facilitate



the work. For example, if the primary winding of the second audio frequency transformer is to be tested it is only necessary to place the test tips on the terminals indicated by the arrows of the chart which point to the P1 and P2 terminals of this transformer.

When testing condensers reference should be made to the schematic diagram Figure 6 and if this drawing indicates a coil to be shunted across any condenser to be tested, remove the leads from one of the condenser terminals

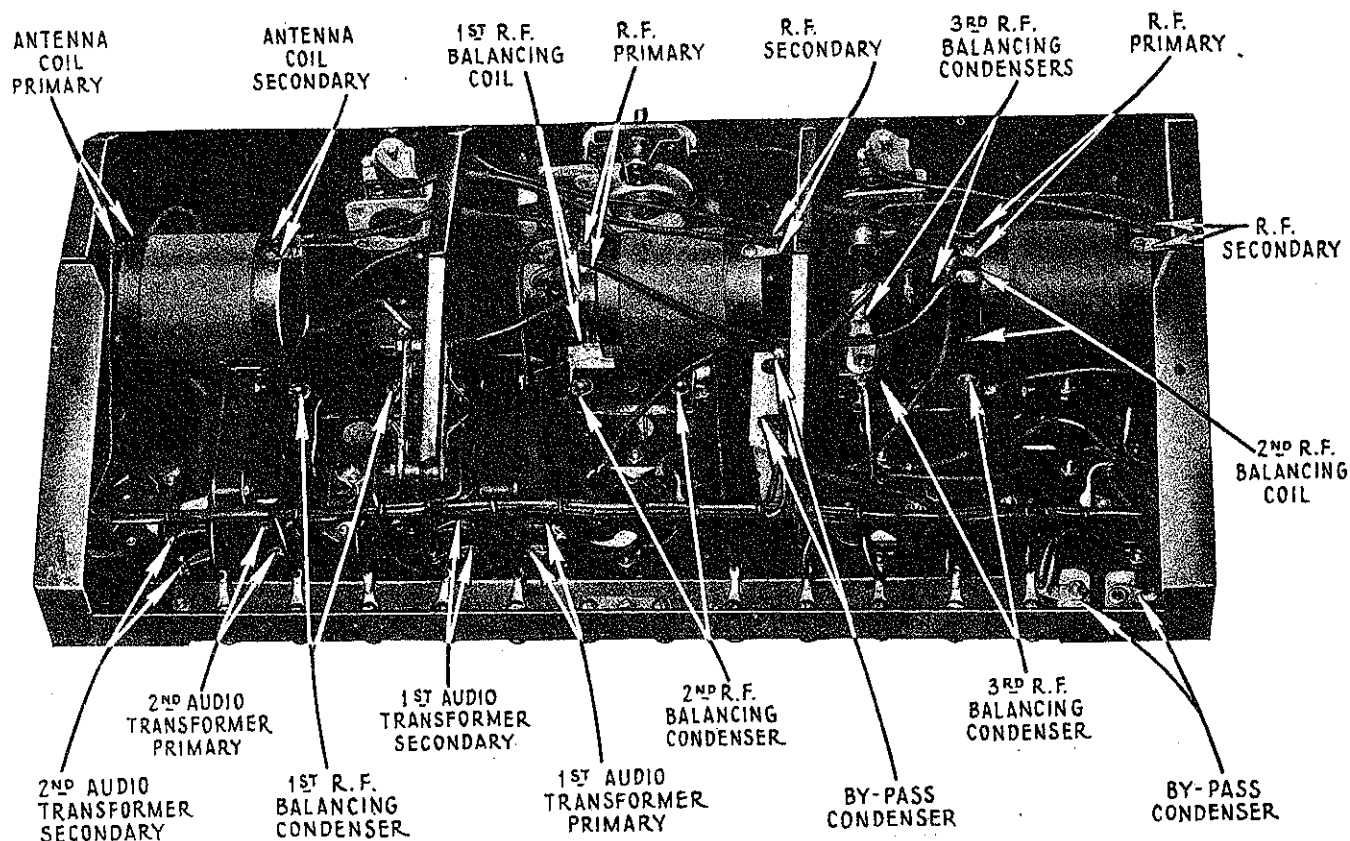


Figure 7

before making the test. This is important and should not be overlooked.

The variable condensers are not shown in Figure 7 as they are mounted on the opposite or top side of the chassis. The method of test suggested for these condensers is to connect a dry cell and a pair of headphones in series. This combination will give the operator two free leads. Connect one of the leads of this combination to the rotor and the remaining lead to the stator plates of the condenser, then slowly rotate the rotor plates and at the same time, listen for sounds in the headphones. If sharp clicks are heard, a short circuit due to improper alignment of either the rotor or stator plates of the condenser is indicated. A visual examination will then determine the point at which the short circuit contact is being made and necessary steps can be taken to separate the plates at this point.

Occasionally the small balancing condensers C2, shown in Figure 6, are changed by tampering from their correct adjustment which is made at the

factory. When this is ascertained they will have to be readjusted. To obtain a good balance, however, practice and skill are required, and unless they are unquestionably out of balance they should never be touched.

To balance any one stage see that the set is in condition to perform as would be the case in normal operation. Tune in a signal that is strong enough to give good volume. Locate the tube belonging to the stage that is to be balanced; remove the tube and place a piece of paper between one of the filament prongs of the tube base and the corresponding socket contact in such a way that when the tube is reseated the tube filament will not light. With the tube filament circuit broken, adjust the condenser C2 of that stage with a socket wrench made of some insulating material, such as a good grade of hard rubber, or bakelite, having a small metal tip. The less metal used in the tip of the wrench the less body capacity effects will be noticed when making the adjustment, and also greater efficiency will be obtained in making the corrections.

Each stage should be carefully adjusted until no sound of the received station can be heard in the speaker. When the corrections have been made remove the paper insulating the filament prong of the tube and proceed in the same manner for other stages that may be found out of adjustment. From practical experience this operation is very rarely necessary. An instance where a complete rebalancing of the circuit is necessary is when receiving tubes having characteristics entirely different than the 201A type are employed.

### ZENITH 17 RECEIVER

The Zenith Model 17 is an electrically operated set employing two stages of radio frequency, a detector, and three stages of transformer coupled audio frequency amplification. This set is available in a table model, a spinet base model, and console model. The addition of the console or spinet base does not influence the reception but answers the requirements relative to the taste of the owner, or as a matter of convenience. The console base houses two built in loudspeakers, one for reproducing tones of the high register, and one for the tones of low register.

Power supply units are installed in spaces provided for that purpose at either end of the cabinet and are supplied with the receiver. These units operate the set directly from the house lighting circuit without the use of batteries.

Before the set can be placed in operation the following accessories must be procured.

- Five 201A or 301A tubes.
- One 171 or 371 " .
- Four Type B-H Raytheon Tubes.
- One console base or an external loudspeaker.

Equipment necessary for the antenna system, namely; aerial, ground equipment and lightning arrestor.

Location of Receiver: The best results are obtained from any receiver when due consideration is given to its location in the house with respect to the point of entrance of the antenna lead-in wire and its proximity to metal masses, such as steel columns concealed in the wall of the building, as would be the case in large apartments, or to concealed wiring and piping. When possible, select a location where the set will be well clear of metal objects and where the lead-in wire can be made as short as possible and connected directly to the set without passing close to concealed wiring, pipes, or other metal masses.

Location of Power Supply: The power supply unit "ZE 5" is housed by the compartment at the extreme left hand side of the receiver cabinet as you look at the back of the set. If the service man is called upon to install one of these units care should be taken to see that it is placed in the compartment in such a way that the switch can be reached by opening the right hand door from the front of the cabinet.

The filter unit should be placed in the compartment at the extreme right hand side of the cabinet so that the end carrying the two loudspeaker binding posts is at the back of the cabinet.

In connecting the set (Figure 8) first see that the long cord from the power supply unit "ZE 5", extends out of the cabinet. This cord is distinguished by the plug at its end which connects the house lighting circuit to the power unit. Do not connect this plug to the 110 volt house current line until all other connections have been made. The short cord from this unit connects with its mate which is secured to the receiving set chassis.

From the filter unit "ZE 6" extends three cords. Pass all three through the hole in the right-hand wooden partition. The longest of the cords with the round and square plugs at the end should be extended over the top of the metal shield of the chassis, through the hole in the left hand wooden partition, and into the left hand compartment where the round plug should be inserted in the round socket of the power supply unit, and the square plug into the square socket.

The long single wire marked "B AMP+" should also be extended across the chassis and connected to the binding post marked "B AMP+" which will be found on the base of the chassis. The remaining cord with the attached multiplug should then be inserted in its socket on the base of the chassis.

When using an outdoor antenna connect it to the antenna post marked "Long", an indoor antenna to the post marked "Short", and the grounding wire to the post marked "GROUND".

The loudspeaker connects to the two binding posts on the rear of the filter unit "ZE 6". All loudspeaker terminals are marked with plus or minus designations, either with the symbols "+" and "-", or by means of colored tracer threads. If the latter method is employed the general rule, unless otherwise stated by the manufacturer, is to connect the speaker terminal carrying a colored tracer to the positive binding post. The polarity, however, is really of no importance when connecting a speaker to this set

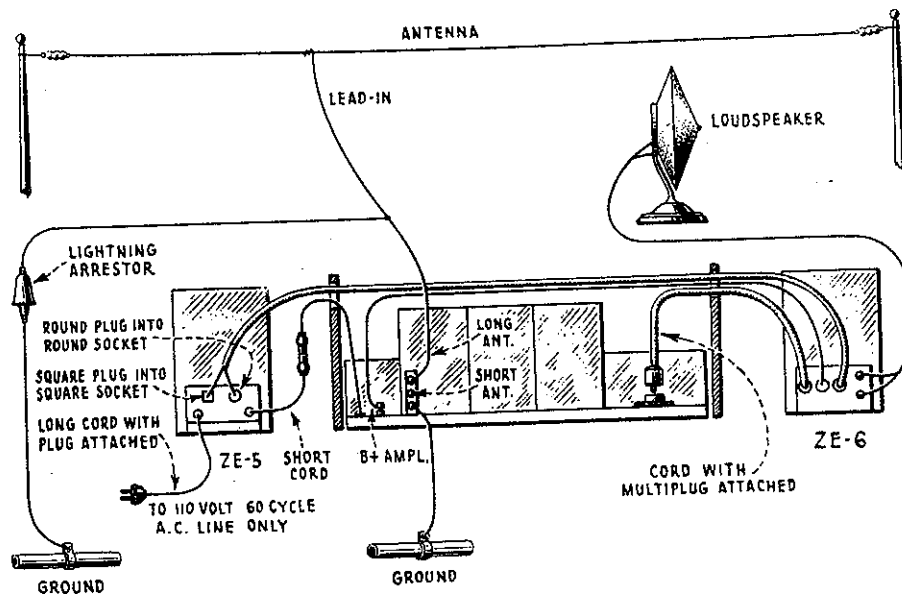


Figure 8

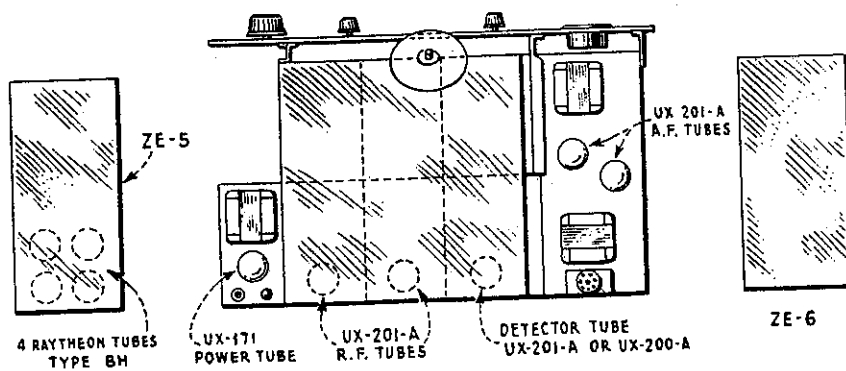


Figure 9

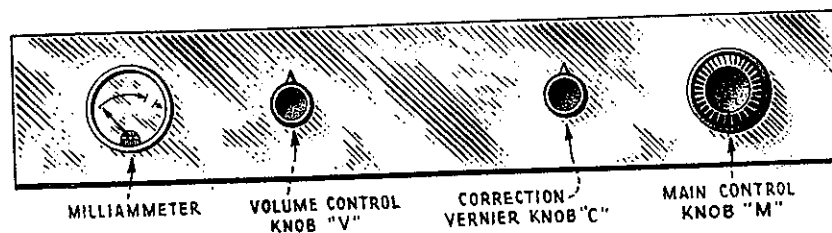


Figure 10

as the D.C. components of the loudspeaker current have been removed by a suitable filter.

Tubes: The four B-H Raytheon tubes are now inserted in the sockets just inside the rear opening of the power supply unit "ZE 5". For proper operation, these tubes must have the same characteristics; that is, they must be perfectly matched. Never substitute an old, or worn out Raytheon tube before attempting to operate the set. Use matched and tested tubes only. Insert the five 201A tubes in the R.F. detector and A.F. sockets and the 171 power tube in the power tube socket. The placement of the tubes is clearly shown in the plan view of the receiver, Figure 9.

Detector tubes such as the 200A type may be used instead of the 201A type if the hissing noise which these tubes sometimes produce is not objectionable. Some of these tubes are quieter than others. If this type tube is used it will perhaps be noticed that the apparent selectivity of the set is lowered; this is not because of any defect in the receiver itself but is due to the great sensitivity of the tube.

NOTE: After the receiver has been in operation a short while the unit "ZE 5" will become hot and will produce a maximum temperature of 130 degrees in the end compartment. This is expected, is normal, and will not harm the wood-work or mechanism of the receiver.

Operation: These sets are designed for use on alternating current of 110 volts at 60 cycles. Before connecting the set, be sure that the house lighting current supply is of the proper characteristics. Adjustments are provided so that successful operation may be obtained with voltages ranging from 90 to 125 volts, and from 50 to 60 cycles. Do not under any consideration connect this set to a Direct Current line. To do so will result in an immediate burn out, thus ruining the receiver.

The attachment cord, shown in Figure 8, may be connected to any convenient outlet near the set. This cord, however, should not be draped directly over or in back of the set, but should be kept at least six or eight inches from the cabinet. This precaution should be observed because of inductive effects. The field about the cord, when current is passing through it, will cause a 60 cycle hum to be heard in the reproducer if the cord is placed directly over or close to the back of the cabinet.

To place the set in operation open the hinged door at the right-hand end of the cabinet and turn the "toggle" switch toward position No. 1. The "off" position is with the switch arm straight out and in the center. The meter on the face of the panel of the receiving set should point to a position at or near the two arrows that indicate the proper operating point for the set. The dial should now be illuminated from the light mounted behind the panel. If the hand on the meter comes to rest in a position between the arrow marks on the meter scale no further adjustment need be made. If, however, the hand is to the left of the arrow marks which indicate the proper operating range, the switch should be moved to position No. 2. Position No. 3 gives still more power and should be used when necessary to make the hand on the meter rest between the arrow marks.

The reading of the meter should be observed occasionally while the set is in operation to see that it remains in the proper position. The toggle switch should be changed when necessary to accomplish this.

To prevent damage to the set always turn the switch to position No. 1 as preliminary procedure when it is desired to place the set in operation. Change the switch to position No. 2 if the meter hand on the panel is not up to the low mark on the dial. In certain instances it may be necessary to set the switch at position No. 3. This procedure must never be reversed. If the meter hand swings above the high mark on the meter dial and remains there a long time, overheating may occur, resulting in damage to parts of the set.

Tuning: The arrangement of the knobs on the panel is shown in Figure 10. Knob "M" is the main tuning control, "C" is a correction vernier, and "V" is the volume control. After tuning in a station set the knob "M" in what appears to be the best adjustment, and then move knob "C" to the position where the signal is loudest. Adjust the volume with the knob V. Under certain conditions a loud hissing may be produced by advancing knob "V" too far to the right. To correct this condition turn knob "V" to the left until the hissing ceases. The use of knob "C" will very seldom be required as it serves only to correct for the detuning caused by the antenna.

If the tubes do not light inspect the tubes themselves and the contact of the tubes in the sockets. Check the tube filaments individually. Make sure that power is being applied to the set from the lighting circuit, that the switch of the set is "ON" and the four Raytheon tubes are properly seated. Make a check of the various plugs in their sockets to see that they are making good electrical contact. If the tubes light but the set is dead, check all tubes in their sockets, and the contacts of the various plugs in their sockets. Inspect the loudspeaker and loudspeaker cord to see that they are in good working condition and properly connected. Tap the detector gently with the finger. If a loud sound is heard in the loudspeaker check up on the antenna and ground connections as the trouble is likely to lie here, or the radio frequency tubes may be defective. If no such sound is heard look for trouble in the audio frequency tubes or loudspeaker.

Poor Volume: Be sure that the hand on the meter rests between the two arrow marks when the set is operated. Check the antenna and ground wires for continuity and for possible short circuit to some metallic object. Check all tubes and tube sockets.

Howling: A loud singing or howling sound will, under certain conditions, be heard in the loudspeaker, gradually building up and sometimes reaching great volume. This sound is usually of low pitch and is practically unaffected by moving the tuning controls. A sound of this nature may be caused by a microphonic tube; interchanging the tubes will usually clear this trouble.

Hum: This sound is a weak continuous musical like note and may be occasionally heard in the loudspeaker, forming a continuous background and is particularly noticeably when no station signals are being received. Such a sound is due to induction from the lighting circuit wires in the house

and may be caused by the antenna or lead-in wire running close or parallel to electric light or power lines, or the cord to the lighting socket from the set runs too close to the back of the set, or the trouble may be that the ground used for the set is the same as the ground used by the electric light company for their ground connections on the lighting mains.

To remedy this condition change the location of the antenna wire, move the attachment cord and try a different ground connection. Reversing the polarity of the attachment plug in the sockets from which the power for the set is obtained may also eliminate the trouble.

Adjustments of Coils and Condensers: The variable condensers and the coils in these sets are balanced at the factory on a special form of A.C. bridge of very great accuracy which makes it utterly impossible to readjust them outside the factory, therefore the coils or condensers should never be tampered with.

Low Line Voltage: In certain localities the line voltage on the lighting circuits may, due to poor regulation, drop even below 90 volts, and as 90 volts is the low minimum at which these receivers will operate it will be impossible to find a position of the switch-lever in the right hand compartment that will give enough power to bring the hand on the meter between the two arrow marks. Under such conditions the operation of the set will suffer. If these extreme cases are met with it will be necessary to install a "booster" transformer obtained from the Zenith factory especially for this set which will raise the line voltage to the proper value.

Tube Selection: Single control receivers operate most efficiently at the lower wavelengths when the tubes in the radio frequency and detector tube sockets have the same inter-electrode capacities. This calls for matched or balanced tubes. It is not sufficient that the tubes be matched up by means of a so-called "tube tester". Matching in this sense is accomplished by trying all of the 201A tubes in various combinations in the sockets to secure the combination that gives the best results. Try this inter-change of tubes when a weak station is tuned in as the effect is much more pronounced than if carried out when a strong signal is being received.

Selectivity: When called upon to inspect a set for selectivity it should first be ascertained whether the lack of selectivity is actual or apparent. The dial of this set covers 360 degrees while dials of many other receivers cover only 180 degrees, hence a station will occupy a greater portion of the dial on the former than on the latter and does not always indicate a lack of selectivity. In case of the Zenith 17 it is an apparent and not an actual lack of selectivity.

Instances have occurred where a long antenna has been connected to the short antenna binding post. This, of course, is wrong and will cause nearby stations to spread over a greater portion of the dial than they normally would if the antenna were connected properly to the long antenna post.

Volume Low on Distant Stations: This condition may exist due to trouble originating from one or more of the following causes:

- (a) A short or inside antenna connected to the long antenna post. The short antenna should be connected to the short antenna post.
- (b) A poor electrical joint or broken connection in the antenna system.
- (c) Grounded or partially grounded antenna.
- (d) One or more defective 201A tubes.
- (e) A defective power tube.
- (f) Defective loudspeaker. If the speaker is of the adjustable type it should be adjusted for greatest volume without rattling or distortion.

Convinced that the tubes and installation are in good order and, on attempting to bring up the volume by means of the volume control on a weak distant signal, the tubes go into oscillation before the desired volume is reached, indicates that the signal is too weak to be tuned in. The set, in such instances, should not be considered inefficient or defective for it is not possible with any radio set to audibly tune in every carrier wave or whistle that is audible in the loudspeaker.

Buzzing: (a) One or more defective Raytheon tubes will cause a buzzing noise that sounds like a hum.

(b) Loose laminations on the large transformer in the "ZE-5" unit. The remedy is to tighten the bolts that hold the laminations of the transformer core together. A short circuited choke coil in the filter unit "ZE-6", or if any of the by-pass condensers in the large condenser unit of the "ZE-6" unit have developed an open, a hum will result.

Make certain that the parallel cable leading from the "ZE-5" to the "ZE-6" unit is properly placed between the spacer blocks and front metal panel. If not it will be too close to the detector tube and a hum will result.

Antenna or ground wires which are too close or parallel to an A.C. current carrying wire of any kind will pick up a hum.

Raytheon Tubes: It is not advisable to use any Raytheon tubes in the "ZE-5" unit other than those that are known to have been especially tested for use with this model receiver. Failure to observe this may result in causing damage to the "ZE-5" unit or cause the other Raytheon tubes to function below their normal efficiency.

A method of testing these tubes for this receiver follows. As this test is a very special test applying only to this receiver, and as it places a severe strain on both the apparatus of the set and the remaining Raytheon tubes, it must only be used when absolutely necessary, and only when no other means of testing is available, therefore use this test with discretion.



The Test: First remove all but one of the Raytheon tubes from their sockets in the power supply unit "ZE-5". Then, with the right hand on the control switch of this unit (located in the right hand compartment), watch the hand on the meter mounted on the panel of the set. Throw the switch lever to position No. 1 for a period not to exceed ONE SECOND, and immediately thereafter return the switch lever to the center or "off" position. Carefully note the approximate maximum reading of the hand during the time the switch is "ON". A good Raytheon tube which is functioning properly will deflect this hand nearly all the way to the lower of the two arrow marks on the meter dial. In the same manner, repeat the process with each of the other Raytheon tubes, one at a time. Replace any tubes which do not function, or which read low, with a new type B.H. tube which gives approximately the same reading as the other tubes. The Raytheon tubes accompanying the receiver are tested prior to leaving the Zenith factory and need not be tested before installation in the set.

High Line Voltage: This will be indicated by the meter needle hand swinging beyond the furthest arrow mark when the switch on the "ZE-5" unit is turned to position No. 1. This set will function properly on a line voltage up to approximately 125 volts.

Failure of Needle to Reach Arrow Marks: If the hand of the meter fails to reach the arrow mark, when the switch on the "ZE-5" is turned to position No. 3, it indicates one or more defective Raytheon tubes, or that one or more of the one-tenth mfd. by-pass condensers in the "ZE-5" unit have developed a short circuit. If one of these condensers is short circuited it will also result in the burning out of a portion of the secondary winding of the large transformer in the "ZE-5" unit.

#### CONTINUITY TEST

The usual equipment for making continuity test which has been described in previous lessons may be employed. If followed carefully it will allow the service man to definitely locate the source of any trouble within the Model 17 chassis or power and filter units. Refer to the diagram, Figure 11.

This test can be grouped into twelve sections covering:

1. Filament circuits.
2. Grid                   "
3. Plate                   "
4. Fixed condensers.
5. Transformer primaries of "ZE 5" unit.
6. Transformer secondaries of "ZE 5" unit.
7. Condenser unit                   "                   "
8. Filter condenser unit of "ZE 6"                   "
9. Double choke                   "                   "
10. Single                   "                   "
11. Condenser                   "                   "
12. Resistance                   "                   "

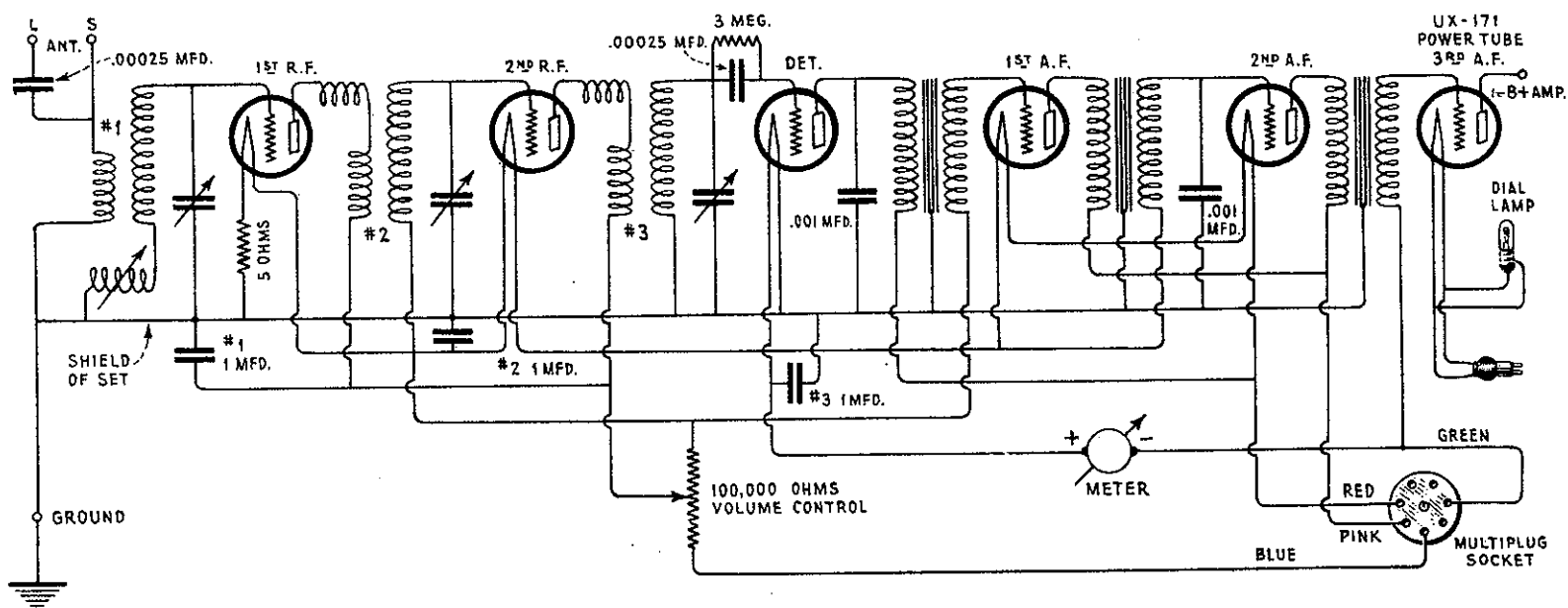


Figure 11

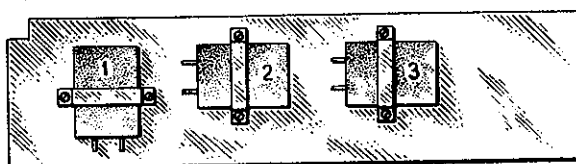


Figure 12

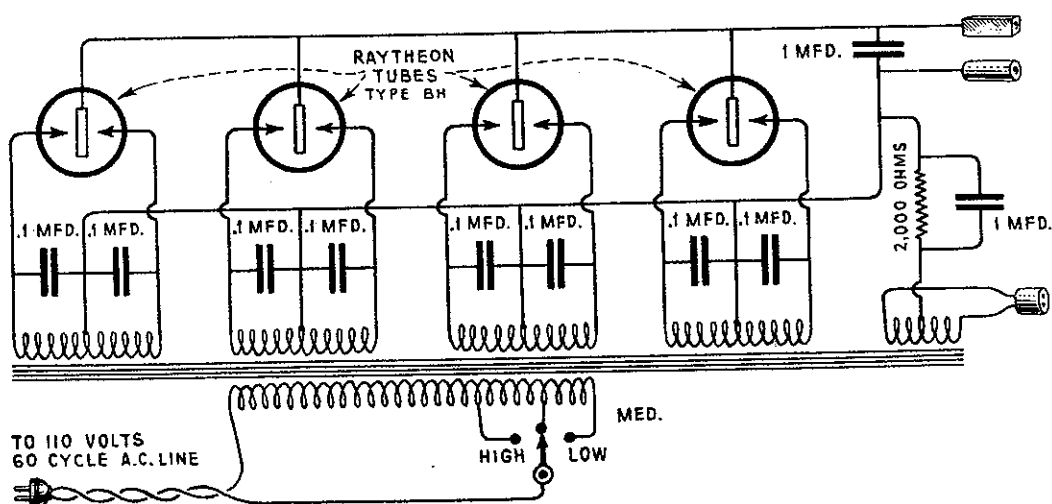


Figure 13

When using the voltmeter test method a deflection of the meter needle will indicate complete circuit. No reading indicates a broken or loose connection between the points being tested.

In testing the filament circuit a voltmeter reading should be obtained in all the following tests unless otherwise stated.

- (1) Place one test tip on the "Red" contact of the multiplug socket to one filament spring of the second audio frequency tube socket.
- (2) From the other filament spring of the second audio frequency socket to one filament spring of the first audio frequency socket.
- (3) From the other filament spring of the first audio frequency socket to one filament spring of the second radio frequency socket.
- (4) From the other filament spring of the second radio frequency socket to one filament spring of the first radio frequency socket.
- (5) From the other filament spring of the first radio frequency socket to the metal shield. (This test takes in the five ohm resistance cartridge and if this cartridge winding is open, or the cartridge not properly seated in its clips, no reading will be obtained on the voltmeter.
- (6) From the metal shield to one filament spring of the detector socket.
- (7) From the other filament spring of the detector socket to the milliammeter terminal which is nearest the variable condenser gang.
- (8) From the other terminal of the milliammeter to the green contact of the multiplug socket.
- (9) Place the test tips across both terminals of the milliammeter. (No reading indicates a burned out meter).
- (10) Test across the two prongs of the double contact male plug when a 171 power tube is not in its socket. This tests the dial lamp and a meter deflection should be obtained unless the dial lamp is burned out.
- (11) Test from one prong of the double contact male plug to one filament spring of the power tube socket. Test from the other prong to the other filament spring of the power tube socket.

#### THE GRID CIRCUIT TEST

- (1) Test from the metal shield to the grid spring of the first radio frequency tube socket. A meter deflection should result. This test takes in the first rotor coil, or "Antenna Correction Vernier", and the secondary winding of the antenna coil, or coil No. 1. When making this test turn the antenna correction knob back and forth to ascertain whether the connections to this rotor coil are secure. No reading indicates that the winding of either coil is open or that the connections to either coil or to the grid spring of the first radio frequency socket are broken or loose.

(2) From the grid spring of the second radio frequency socket to (minus) filament spring in the same socket. This test takes in the secondary winding of coil No. 2. Meter deflection indicates the secondary winding of coil No. 2; i.e. second R.F. transformer winding is perfect. No reading indicates this coil is open or a broken connection.

(3) Next test from the grid spring of the detector socket to one side of the grid condenser which should show a reading. Test across the .00025 mfd. grid condenser. This test should show no reading. A reading indicates a short circuited condenser. Test from the other side of the grid condenser to the metal shield. This takes in the secondary winding of coil No. 3. A meter deflection should result. No reading indicates this coil to be open or a broken connection.

(4) Test from the grid spring of the first audio frequency socket to the (plus) filament prong of the first radio frequency socket; this should show a LOW reading. This takes in the secondary winding of the first audio frequency transformer. A full reading indicates a short circuited transformer winding. No reading indicates an open transformer winding or broken connection.

(5) Test from the grid spring of the second audio frequency socket to (minus) filament spring of the first audio frequency socket. This test takes in the secondary winding of the second audio frequency transformer and should show a low reading.

(6) Next test from the grid spring of the second audio frequency socket to the metal shield. No reading should be obtained unless the 0.001 mfd. by-pass condenser which is between these two points is short circuited or the transformer winding is grounded to its core.

(7) Test from the grid spring of the power tube socket to the "green" contact of the multiplug socket. This takes in the secondary winding of the third audio frequency transformer and should show a LOW meter reading. In making these tests the reading through the first audio frequency transformer winding should be less than through the second and third transformers as the first transformer is of higher ratio.

#### PLATE CIRCUIT TEST

(1) Place the test points across the plate spring of the first radio frequency socket and the blue contact of the multiplug socket. With the volume control turned completely to the right this test should give a full meter reading. Turning the volume control to the left will cause deflection of the meter needle. This test takes in the rotor and primary winding of coil No. 2. If no reading is obtained when the volume control is turned to the right, it would indicate open rotor or primary coil winding, loose or a broken connection.

(2) Testing from the plate spring of the second radio frequency socket to the blue contact of the multiplug socket which takes in the rotor and primary windings of coil No. 3. The results of this test should be the same as test No. 1.

(3) From the plate spring of the detector socket to the "red" contact of the multiplug socket which takes in the primary winding of the first audio frequency transformer should show a low reading. Full reading would indicate a short circuited transformer winding. If no reading at all is observed the transformer winding is open or a broken connection exists.

(4) Testing between the plate spring of the detector socket to the metal shield should indicate no reading unless the 0.001 mfd. by-pass condenser, which is between these two points, is short circuited.

(5) From the plate spring of the first audio frequency socket to the "Pink" contact of the multiplug socket a low reading should be observed. This test takes in the primary winding of the second audio frequency transformer. A full reading indicates a short circuited transformer winding. No reading at all shows the transformer to be open, or a broken connection.

(6) From the plate spring of the second audio frequency socket to the "Pink" contact of the multiplug socket takes in the primary winding of the third audio frequency transformer. The results for this test are the same as test No. 5.

(7) Testing from the plate spring of the power tube socket to the "B" amplifier plus binding post should show a full reading. No reading indicates a broken connection.

#### FIXED CONDENSER TEST

There are three of these condensers each having a capacity value of 1 mfd. and are numbered No. 1, No. 2, and No. 3. Their actual placement on the sub-panel is shown in Figure 12.

(1) Touch the test tips to both connections of the condenser under test. No reading should result. A slight reading each time contact is made indicates a leaky condenser. A full reading each time indicates a short circuited condenser. Another test without the use of a meter may be applied. Momentarily connect a "B" battery across the condenser terminals. This will place a charge on the condenser. If the condenser is in proper condition a spark should then be obtained when short circuiting the condenser with a piece of wire.

(2) If condenser No. 1 is open there will be no noticeable effect on the operation of the receiver, but if condenser No. 2 or No. 3 is open the receiver will not oscillate on the longer wavelengths.

#### THE "ZE-5" POWER UNIT

Transformer Primary: For this test place the test tips across the prongs of the male lamp cord plug. A full meter reading should be obtained when the switch is in either positions No. 1, No. 2 or No. 3 on the panel. These positions are taps taken from the primary of the power transformer shown in Figure 13.

(a) Transformer Secondaries: Touching one test lead to each filament prong of one Raytheon tube socket will take in one secondary winding of the transformer. A reading should be obtained of a little better than one-half of the voltage of the battery used in making the test. This test should be made on all four of the Raytheon sockets.

(b) Testing from one filament prong of any Raytheon tube socket to the square plug jack, which takes in one-half of one secondary winding of the transformer, a reading should be obtained somewhat higher than in test "A". When making this test it should be made from all eight filament prongs of the four Raytheon tube sockets. A full reading would indicate one-half of one secondary winding of the transformer being shorted out by the one-tenth mfd. condenser. This may result in a burned out

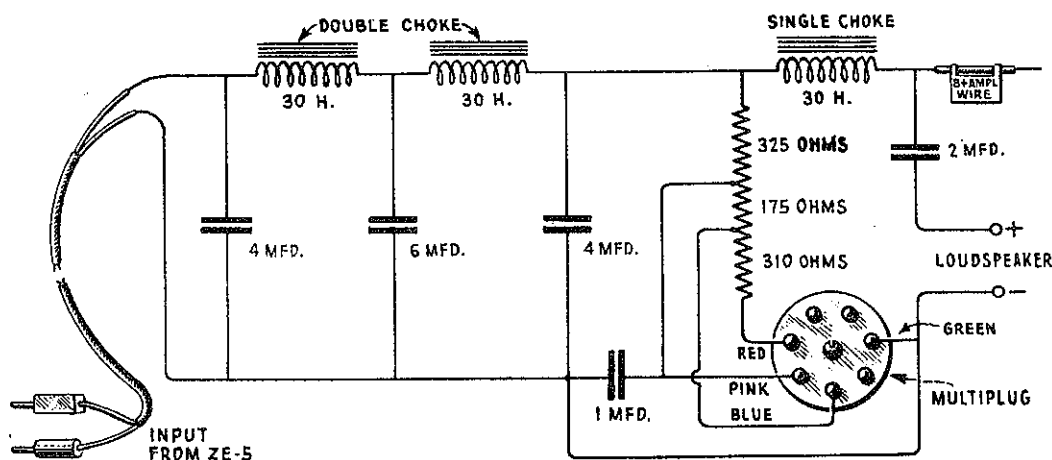


Figure 14

transformer winding. Test of the secondary winding for the power tube is made by placing the test tips across the double contact of the miniature socket plug. A full reading should be obtained. No reading indicates this part of the winding burned out.

Condenser Unit: Testing between one contact of the miniature socket to the square hole jack should give a low momentary reading, as it takes the 2000 ohm resistance and the 1 mfd. condenser. A full reading would indicate that the 1 mfd. condenser was short circuited.

Testing between the round hole and the square hole jacks should result in no reading other than a momentary deflection of the needle. A reading indicates that the 1 mfd. condenser short circuited.

When testing any of the condensers in this unit, and if any single condenser is found faulty, it will be necessary to replace the entire condenser "Can" as one individual condenser unit cannot be removed or replaced.

#### THE "ZE-6" FILTER UNIT

Filter Condenser Unit: The "ZE-6" filter unit is shown in Figure 14. When the test points are placed across the square plug phone tip and the

round phone plug tip the meter needle should be momentarily deflected, immediately returning to zero. Such a deflection is sometimes called a "kick forward." If a steady reading is obtained it indicates that one or more of the condensers units within the can are short circuited. As it is not possible to remove separate units from the can it should be replaced by a new can.

The Double Choke: To test this choke touch one test point to the round plug phone tip and the other to the terminal on the single choke that has the "yellow" wire attached to it. A reading of a trifle more than one-half of the voltage of the battery used in testing should result. A higher reading indicates one choke coil is short circuited. A full reading indicates both chokes are short circuited. No reading at all would indicate an open choke winding.

Single Choke: Touch one lead of the test equipment to one terminal of the single choke and the other test point to the other choke terminal. A reading should result of a trifle over one-half of the battery voltage used in testing. Full reading indicates the choke to be short circuited. No reading at all indicates the choke coil to be open.

Condenser: Test from the minus loudspeaker post to the pink prong of the multiplug. No reading should result. Only a slight deflection of the meter needle should be observed when the test leads are first applied. A full deflection indicates that the 1 mfd. condenser between these points in the condenser can is short circuited. When testing from the plus loudspeaker post to the "B" plus amplifier wire no reading should result. Only a slight deflection of the meter needle when the test leads are first applied should be observed. This tests the 2 mfd. condenser. If the condenser is open no deflection will result.

Resistances: From the red to blue contacts of the multiplug a low reading should be observed. This test takes in the 310 ohm section of the vitrohm resistance unit. No reading indicates a broken connection or open resistance unit. Testing from the blue to pink contacts of the multiplug takes in the 175 ohm section of the vitrohm resistance unit. No reading indicates an open in this section, or broken connection.

From the pink of the multiplug to the yellow wire on the single choke takes in the 325 ohm section of the vitrohm resistance. No reading indicates an open in this section of the resistance, or a broken connection. Testing from the red contact of the multiplug to the yellow wire on the single choke takes in all the 810 ohms of resistance. The higher the resistance tested the lower should be the reading on the test meter.

EXAMINATION - LESSON 47

1. Can the Zenith 17 receiver be operated from a source of direct current?
2. What is the method of controlling the tube filaments in the Crosley 90 receiver?
3. What method is employed to control the volume of the Crosley 90 receiver?
4. What is the most practical method of matching tubes for use in any set?
5. When using a Zenith 17 receiver, what procedure is necessary when the line voltage is consistently below normal?
6. How is sharp tuning accomplished with the Crosley 90?
7. What precautions should be exercised relative to the use of rectifier tubes in the "ZE-5" unit of the Zenith 17?
8. What type of vacuum tube is the Crosley 90 designed for?
9. What effect may be produced in the Zenith 17 if the laminations of the large transformer of the "ZE-5" unit are loose?
10. What type circuit does the Crosley 90 employ?